Concentrating on Whey Protein Isolate

By Lynn A. Kuntz, Editor-in-Chief

Not so long ago, whey was considered a valueless cheese byproduct that was used as animal feed. However, food researchers have discovered the protein component has a high nutritional value and provides a range of functional properties that prove valuable in a number of food applications: dairy, bakery, meat, snack, confectionery, beverages, and other food and nutritional products.

Whey to isolate

Cow's milk contains approximately 3.5% protein, about 18% of which are whey proteins, mainly lactalbumin (about 12% of the whey protein) and lactoglobulin (about 50% of the whey protein), and about 82% are caseins. During cheesemaking, the casein proteins precipitate out in the acidic environment and/or are coagulated by rennet to form the cheese while the whey proteins stay in solution. This liquid whey contains proteins, peptides, lactose, milkfat and other lipids; mineral salts and ions, such as sodium, potassium and calcium; vitamins; and water.

Manufacturers remove the water and concentrate the whey proteins, ending up with a white to cream-colored product containing 90% or more protein called whey protein isolate (WPI). A typical WPI powder will contain approximately 92.0% protein, 4.5% moisture, 2.0% ash, 1.0% fat and 0.5% lactose. However, modifying manufacturing technology creates whey isolate products with varying composition and functional properties.

"WPI composition is affected primarily by its method of manufacture," notes Grace Harris, manager of new business and applications, Hilmar Ingredients, Hilmar, CA. "The two most-common methods of WPI manufacture are microfiltration (MF) and ion exchange (referred to as IX or IE). These methods create minimal difference in nonprotein components such as fat, lactose and minerals. By its nature, at greater than 90% protein, WPI has a very low content of these components to begin with. The main differences created by the two methods of manufacture are in the protein fraction content and some functionality."

For example, "ion-exchange WPI contains high levels of beta-lactoglobulin and no glycomacropeptide," explains Eric D. Bastian, Ph.D., vice president, research & development, Glanbia Nutritionals, Monroe, WI. "Alternatively, MF WPI contains lower levels of beta-lactoglobulin but high levels of glycomacropeptide."

Enzymatic hydrolysis can also alter WPI functionality. "This allows processors to create an ingredient with widely varying functional and nutritional attributes," says Bastian. "The degree of hydrolysis, specificity of proteolytic enzymes used, temperature and pH of hydrolysis all affect the functionality of the hydrolyzed WPI. The possible hydrolyzate variations are almost infinite.

"Mineral content can also be manipulated through membrane and electrodialysis processing techniques," Bastian continues. "Mineral profile significantly impacts the functional properties of WPI, presenting the opportunity for specialized functionality."

Pro nutrition

WPI can supply a concentrated source of high-quality protein for supplementation. Whey protein is a complete protein; it contains all 20 amino acids and all 9 essential amino acids in amounts proportional to the human body's needs. Its protein digestibility corrected amino acid score (PDCAAS) is 1.14, and its biological value (BV) is 104. Whey protein also contains high concentrations of amino acids that are metabolized at high rates during exercise, particularly glutamine and leucine.

"In comparison to other protein isolates, WPI has a distinct advantage in amino-acid profile because whey proteins are higher in essential amino acids, especially branched-chain and sulfur-containing amino acids," says Bastain. "WPI customers should review the amino-acid profile of protein isolates to determine which of these fit their specific application needs. This nutritional advantage can be applied to a wide variety of applications, including high-protein energy bars and beverages."

Harris notes that, "because it's at least 90% protein on a dry basis, whey protein isolate delivers a very high protein content to foods and beverages.WPI can also provide clarity and heat stability, key for transparent applications such as protein waters, isotonics and protein shots. With its very low fat and lactose content, WPI is ideal for use in formulations where those components are at a minimum."

Isolating functionality

In general, WPI has good emulsifying, fat-binding, and water-binding or thickening properties. It can also be added to products to take advantage of its gelling and whipping properties

"WPI makes an excellent replacer for other ingredients. For example, when eggs are not desirable due to cost, allergen or other issues, WPI can be used instead," suggests Harris. "It provides aeration in baked goods such as muffins or cakes, and it whips into mousse and toppings."

The choice of a particular WPI depends on the application and the specific functional characteristics provided by the WPI manufacturing process. The compositional variances "offer distinct functional and nutritional benefits," says Bastian. "For example, a WPI rich in beta-lactoglobulin would be suitable for a high-gel product because beta-lactoglobulin has a strong gelling protein. Glycomacropeptide triggers hormones that may signal fullness and act as a satiety peptide. As a result, MF WPI could be used in a weight-management product. Formulators using WPI need to understand these two major types of WPI and examine their functional differences in specific applications, such as protein bars and ready-to-drink beverages."

WPI is soluble or forms a stable colloidal dispersion at ambient temperature and under all pH conditions. "In general, WPI will provide low viscosity when used in liquid products," says Harris. "A product's viscosity is dependent on the amount of WPI used, type of thermal processing and stabilizer

systems. These parameters can be altered in both the formula and the process to either increase or reduce viscosity."

While WPI is very stable across the entire food pH range, "in clear beverage applications, which are generally hot-fill beverages, the pH needs to be around 3 to maintain good stability and solubility," says Bastian. "Smoothies, which also require heat, can be made at higher pH levels, but above pH 4.0 to 4.5, specialized processes and stabilization systems need to be utilized for maintaining stability. Neutral pH is also a region that is generally unstable for WPI in heated applications like beverages, so stabilization systems are important."